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Depression After Spinal Surgery: A Comparative Analysis of the California Outcomes Database

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Abstract

Objective—To examine the relative incidence of newly recorded diagnosis of depression after spinal surgery as a proxy for the risk of post—spinal surgery depression.

Patients and Methods—We used the longitudinal California Office of Statewide Health Planning and Development database (January 1, 2000, through December 31, 2010) to identify patients who underwent spinal surgery during these years. Patients with documented depression before surgery were excluded. Risk of new postoperative depression was determined via the incidence of newly recorded depression on any hospitalization subsequent to surgery. For comparison, this risk was also determined for patients hospitalized during the same time period for coronary artery bypass grafting, hysterectomy, cholecystectomy, chronic obstructive pulmonary disease, congestive heart failure exacerbation, or uncomplicated vaginal delivery.

Results—Our review identified 1,078,639 patients. Relative to the uncomplicated vaginal delivery cohort, the adjusted hazard ratios (HRs) for newly recorded depression within 5 years after the admission of interest were 5.05 for spinal surgery (95% CI, 4.79–5.33), 2.33 for coronary artery bypass grafting (95% CI, 2.15–2.54), 3.04 for hysterectomy (95% CI, 2.88–3.21), 2.51 for cholecystectomy (95% CI, 2.35–2.69), 2.44 for congestive heart failure exacerbation (95% CI, 2.28–2.61), and 3.04 for chronic obstructive pulmonary disease (95% CI, 2.83–3.26). Among patients who underwent spinal surgery, this risk of postoperative depression was highest for patients who underwent fusion surgery (HR, 1.28; 95% CI, 1.22–1.36) or had undergone multiple spinal operations (HR, 1.22; 95% CI, 1.16–1.29) during the analyzed period.

Conclusion—Patients who undergo spinal surgery have a higher risk for postoperative depression than patients treated for other surgical or medical conditions known to be associated with depression.

The psychosocial effects imposed on patients who undergo major surgery[1] or have debilitating chronic disease[2,3] cannot be overstated. Many patients experience postoperative

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SUPPLEMENTAL ONLINE MATERIAL

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depression after major surgical interventions, including coronary artery bypass grafting (CABG),[4,5] hysterectomy,[6] and cholecystectomy.[7] Similarly, the risk of depression in patients who have incapacitating chronic diseases (eg, congestive heart failure [CHF] and chronic obstructive pulmonary disease [COPD]), is striking.[2,3] Despite our understanding of depression risks in these diseases, the risk of newly diagnosed depression after spinal surgery remains poorly studied. We used the California Office of Statewide Health Planning and Development (OSHPD) database (January 1, 2000, through December 31, 2010) to explore the risk of newly diagnosed depression after spinal surgery.

PATIENTS AND METHODS

Data Source

This study used the California OSHPD longitudinal inpatient-discharge administrative database from January 1, 1995, through December 31, 2010.[8] In California, each time a patient is treated in a licensed acute care hospital, a record is submitted to the OSHPD database. The reported data include patient demographic information such as age, sex, race/ethnicity, diagnostic information, treatment information, disposition, total charges, and expected source of payment. Diagnostic and treatment information is based on the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes. Each patient in the database is assigned a unique masked identifier, which allows tracking of patients throughout multiple inpatient hospital stays and over multiple years in the state of California.

Study Design

We applied a novel study design that we have termed an *in silico prospective cohort design*. In this design, we first identified a population of patients who underwent spinal surgery without a previous or concurrent diagnosis of depression. We then longitudinally followed this cohort to identify newly recorded depression diagnoses on subsequent hospitalizations as a proxy for risk of postoperative depression. Parallel analyses were performed for patients who underwent CABG,[4,5] hysterectomy,[6] or cholecystectomy[7] and for patients who were hospitalized with medical conditions known to be associated with depression including CHF[2] and COPD.[3] A cohort of patients who underwent uncomplicated vaginal deliveries was also identified and studied as a reference population because it represented a hospitalized patient population with relatively low comorbidity burden.

Inclusion and Exclusion Criteria

Patient selection criteria for this study are detailed in the Figure. All included patients were assigned an “index admission” corresponding to their first hospitalization on record related to a particular surgical procedure or medical diagnosis (eg, spinal surgery, CABG, hysterectomy). We examined index admissions beginning on January 1, 2000, in order to ensure a minimum of 5 years of prior hospitalization information (dating back to January 1, 1995, the start of the OSHPD data set) with which to determine hospitalization history. Our primary patients of interest to be considered for analysis—collectively referred to as our *spinal surgery cohort*—consisted of all adult patients younger than age 65 years who were hospitalized primarily for spinal surgery between January 1, 2000, and December 31, 2010.

Patients with a history of depression (dating as far back as January 1, 1995) or with depression recorded on their index admission were excluded. Patients were also excluded if they had a history of spinal surgery, CABG, hysterectomy, cholecystectomy, normal delivery, CHF exacerbation, or COPD exacerbation. A comparison set of patients was identified—collectively referred to as our *comparative cohort*—that included adult patients younger than age 65 years who were hospitalized for a variety of common medical conditions and surgical procedures: CABG, hysterectomy, cholecystectomy, vaginal delivery, admission for CHF exacerbation, or admission for exacerbation of COPD (for relevant *ICD-9-CM* codes, see Supplemental Appendix, available online at http://www.mayoclinicproceedings.org). Patients were excluded from the comparison cohort if they had a history of depression, had a diagnosis of depression on arrival for the index admission for their respective diagnosis/surgery, had previously been admitted for spinal surgery, or had any previous admission for CABG, hysterectomy, cholecystectomy, normal delivery, CHF, or COPD.

Patients who underwent spinal stimulator placement surgery during their index admission were also excluded because spinal stimulators are typically placed after failure of multiple operations.[9] This patient cohort likely underwent their index spinal surgery in another state. Finally, patients from both cohorts were excluded from the entire analysis if they had a history of diagnosis of trauma to the head, spine, liver, gallbladder, heart, lungs, or pelvic organs at the time of their index admission or if they received any combination of the aforementioned surgical or medical diagnoses during the years of our analysis. The risk of postoperative depression (see “Outcomes” section) was analyzed and compared between these patient cohorts.

After our initial comparative analysis, our spinal surgery cohort was split into 3 categories: (1) patients who underwent a spinal fusion operation during their index admission and this admission was the only one during the study period related to spinal operations, (2) patients who underwent a nonfusion spinal operation during the index admission and this admission was the only one during the study period related to spinal operations, and (3) patients who underwent more than one spinal surgery (of any kind, including fusion) during the analyzed period. The risk of postoperative depression (see “Outcomes” section) was also analyzed and compared between these patient categories.

Outcomes

The primary outcome of interest was the presence of any diagnosis of depression on hospital admission subsequent to the index admission. Patients were followed up from the time of their index admission until study end (limit of 5 years), death, or the outcome of interest was reached. Any subsequent hospital admissions were examined for the recording of an *ICD-9-CM* diagnosis of depression. We utilized this recording as a proxy for previously undiagnosed depression. Once a patient was identified as being readmitted to the hospital with newly diagnosed depression, he/she was considered to have had an event and was removed from the risk set for the purposes of our analysis. Patients were censored if their depression diagnosis followed any of the traumatic events outlined previously (ie, trauma to

the head, spine, liver, gallbladder, heart, lungs, or pelvic organs). Finally, time to event data for each admission indication was recorded.

The secondary outcome of interest was the presence of any diagnosis of depression on hospital admissions following a subset of spinal operations (exclusive of other hospital admission indications) chosen to reflect a degree of invasiveness and disease severity. The same approach outlined for our primary outcome was used to investigate this secondary outcome.

Covariates

We controlled for patient age, sex, race/ethnicity, length of hospital stay, insurance status, comorbidities (via Charlson Comorbidity Index score), source of admission, and transfer status on the index admission, as well as the total number of hospital episodes (hospitalizations including transfers) following the index admission for each patient. We reasoned that patients who underwent multiple hospitalizations were likely to have compromised quality of life and consequently experience depression relative to patients who underwent a single hospitalization. As such, we included this variable in our analysis. All covariates were included on the basis of their clinical relevance and importance to the investigation of our research question.

For the spinal surgery subset analysis, we included an additional covariate, primary indication for spinal surgery, in order to control for differences in underlying pathology not accounted for by surgical subtype alone. The surgical indications included for this analysis represented the 7 most common diagnosis groupings among the spinal surgery cohort. The remaining *ICD-9-CM* diagnosis codes (each of which represented <0.5% of all diagnoses) were combined as a group labeled “other.”

Statistical Analyses

All statistical analyses were performed using Stata/SE statistical software, version 11.2 (StataCorp), with statistical significance defined as $P<.05$ and using only 2-sided tests.

Baseline characteristics were compared between groups using the *t* test, analysis of variance, and χ^2 test. The incidence of previously undiagnosed depression present on subsequent hospital admission(s) was assessed using a Kaplan-Meier plot and further investigated with a multivariate Cox proportional hazards model adjusting for the aforementioned covariates. The patients who had undergone uncomplicated vaginal delivery were set as the reference group for overall hazards modeling because these patients were, on the whole, hospitalized for a non—disease-related diagnosis.

Within the spinal surgery cohort, a subset analysis was performed using a Cox proportional hazards model to describe the relative hazards of depression diagnosis for patients who underwent spinal fusion procedures, multiple spinal operations following their index surgery, or one-time nonfusion spinal surgery, again adjusting for all of the aforementioned covariates plus primary surgical indications for reasons outlined previously. For this analysis, those patients who did not undergo fusion or multiple spinal operations were set as the reference group (ie, one-time nonfusion spinal surgery patients) for hazards modeling.

RESULTS

Study Cohorts

In total, we identified 1,078,639 patients without a prior diagnosis of depression who were admitted for spinal surgery, CABG, hysterectomy, cholecystectomy, vaginal delivery, CHF exacerbation, or COPD exacerbation between 2000 and 2010. Of these patients, 200,911 (18.6%) had an index admission for spinal surgery, 39,549 (3.7%) for CABG, 297,928 (27.6%) for hysterectomy, 212,010 (19.6%) for cholecystectomy, 53,718 (5.0%) for CHF exacerbation, 25,618 (2.4%) for COPD exacerbation, and 248,905 (23.1%) for uncomplicated vaginal delivery. Baseline demographic characteristics for each cohort are presented in Table 1. Statistically significant differences were noted between the various cohorts with respect to mean age, sex, race/ethnicity, length of hospital stay for index surgery, insurance status, comorbidities, number of hospital episodes, source of admission, and transfer status on univariate analysis (all $P<.001$). The vaginal delivery and cholecystectomy cohorts were generally younger. Sex differences and Charlson scores in each cohort were consistent with the various physiologic features of each underlying condition.[10]

Newly Recorded Depression on Hospitalization Subsequent to the Index Surgery

Of the 1,078,639 patients included in our analysis, 36,762 patients (3.4%) were found to have newly recorded depression diagnoses on hospitalization within 5 years of their index admission. The number (and proportion) of patients within each respective cohort that had newly recorded depression on subsequent hospitalization were as follows: spinal surgery, 10,257 of 200,911 (5.1%); CABG, 1062 of 39,549 (2.7%); hysterectomy, 7825 of 297,928 (2.6%); cholecystectomy, 6854 of 212,010 (3.2%); CHF, 5538 of 53,718 (10.3%); COPD, 3041 of 25,618 (11.9%); and uncomplicated vaginal delivery, 2185 of 248,905 (0.9%). Baseline demographic data for spinal surgery patients with and without newly recorded depression after index surgery are presented in Table 2 (for comparative cohort data, see Supplemental Table A, available online at http://www.mayoclinicproceedings.org). Statistically significant differences were noted in baseline characteristics between these groups. Specifically, within the spinal surgery cohort, patients whose records indicated newly diagnosed depression were more likely to be female, older, and white (all $P<.001$). They were also more likely to have a higher Charlson comorbidity score, longer hospital stay, and nonprivate insurance on their index admission (all $P<.001$). Finally, they were more likely to be transferred during their index admission, to have been readmitted multiple times subsequent to their index admission, and to have been admitted for operations for treatment of spinal metastases (all $P<.001$) (Table 2).

Time to Newly Recorded Diagnosis of Depression

Unadjusted time to event analysis for the entire cohort revealed the median time interval between the index admission and the subsequent admission with the newly recorded diagnosis of depression. In increasing order, the median (range) time to event data in months were 16.5 (0.13–60.0) for CHF, 17.7 (0.10–59.93) for COPD, 19.8 (0.23–59.93) for CABG, 21.5 (0.20–59.97) for cholecystectomy, 21.9 (0.13–60.0) for spinal surgery, 26.7 (0.26–60.0)

for hysterectomy, and 30.5 (0.43–60.0) for vaginal delivery (Table 2 and Supplemental Table A).

Adjusted Risk of Newly Recorded Diagnosis of Depression

Using a Cox proportional hazards model, we estimated the risk of incurring a newly recorded diagnosis of depression by calculating a hazard ratio (HR) adjusted for age, sex, race/ethnicity, length of hospital stay, insurance status, comorbidity burden, source of admission, and transfer status on index admission, as well as the number of hospital episodes (hospitalizations including transfers) following the index admission. Relative to the uncomplicated vaginal delivery cohort, the adjusted HR for postoperative depression within 5 years of the index surgery (as assessed by the HR) was 5.05 (95% CI, 4.79–5.33) in the spinal surgery cohort, 2.33 (95% CI, 2.15–2.54) in the CABG cohort, 3.04 (95% CI, 2.88–3.21) in the hysterectomy cohort, 2.51 (95% CI, 2.35–2.69) in the cholecystectomy cohort, 2.44 (95% CI, 2.28–2.61) in the CHF cohort, and 3.04 (95% CI, 2.83–3.26) in the COPD cohort (Table 3). Complete analyses with values for all covariates of interest are available in Supplemental Table C (available online at http://www.mayoclinicproceedings.org).

To assess whether our results could be attributable to discomfort related to early postoperative recovery, we calculated the adjusted risk of incurring a newly recorded diagnosis of depression for each cohort within 1, 2, 3, and 4 years after the index admission. As evidenced in Table 3, the HRs for postoperative depression in each cohort were highest in the first year, suggesting that the risk of depression decreases with length of postoperative recovery. Although this risk decreased with time, it remained substantially elevated 5 years after the index surgery/admission, suggesting that factors beyond postoperative recovery contributed to our observations.

Subset Analysis by Specific Spinal Surgery Type

We identified patients who were more likely to have “failed back surgery syndrome,”[11,12] including patients who underwent fusion surgery[11] (n=83,151) and those who underwent multiple spinal operations[12] (n=35,417) during our years of analysis. The HRs for our spinal fusion and multiple spinal surgery cohorts were 1.28 (95% CI, 1.22–1.36) and 1.22 (95% CI, 1.16–1.29), respectively, relative to those patients who underwent all other spinal surgical procedures (ie, one-time spinal surgery without fusion, n=82,343) (Table 4 and Supplemental Table B [available online at http://www.mayoclinicproceedings.org]). These results are consistent with an increased risk of postoperative depression for those patients at greatest risk for failed back surgery syndrome.

DISCUSSION

Our study applied a novel design to the OSHPD database to explore a critical issue in spinal surgery—the risk of new depression after spinal surgery. We used a newly registered depression diagnosis on hospitalization following surgery as a proxy for the incidence of depression as a means to study post—spinal surgery depression. Using this approach, we confirmed previous reports of postoperative depression in patients who underwent surgical interventions (ie, CABG, hysterectomy, and cholecystectomy)[5–7] or who were hospitalized

for chronic debilitating illnesses (ie, CHF, COPD).[2,3] Impressively, the risk of postoperative depression after spinal surgery was considerably higher than for cohorts of patients who underwent CABG, hysterectomy, or cholecystectomy or who were admitted for CHF or COPD exacerbation. Furthermore, of the patients who underwent spinal surgery, the risk of depression was highest for those patients who underwent fusion surgery and who required more than one spinal surgery during our analyzed period.

There are several potential explanations for the association between spinal surgery and postoperative depression. It may be that patients seeking interventions for incapacitating pain/discomfort are simply predisposed to becoming depressed. The prevalence of major depression in patients with chronic low back pain, for instance, has been reported to be as high as 54%.[14] Alternatively, depression may be the result of symptom persistence after the procedure or morbidity incurred from the procedure. Our observation that patients who underwent spinal fusion (known to have a higher risk for complications and surgical failure than nonfusion surgery[15,16]) or multiple spinal operations (frequently performed after failure of an initial surgery[13]) were at higher risk for postoperative depression is in support of this second hypothesis. We recognize that these 2 hypotheses are not mutually exclusive and may both contribute to the observed association. Unfortunately, the data contained within the OSHPD data set was insufficiently granular to provide further dissection among these possibilities.

The high proportion of patients who experience depression after spinal surgery presents a difficult challenge in the assessment of the efficacy of these operations. It is a well-described phenomenon that patients with depression exhibit heightened perception of pain.[17,18] Moreover, depression negatively impacts quality of life[17] as well as ability to work.[19,20] Because the efficacy of elective spinal surgery is typically evaluated in the context of pain control, quality of life improvement, and ability to work, it is likely that these assessments are confounded by the prevalence of depression. An important implication of our work is that psychiatric assessment in terms of depression should be routinely incorporated in trials designed to assess the efficacy of spinal surgery, such as the SPORT (Spine Patient Outcomes Research Trial) studies.[21]

It is important to note that our study likely underestimates the risk and prevalence of depression after spinal surgery. First, our study design relies on capturing the diagnosis of depression on the basis of subsequent hospitalization. Because depression is typically treated on an outpatient basis, our study necessarily captures only the subset of patients who experienced depression after spinal surgery and were subsequently hospitalized for any reason. Second, our study excluded at the outset patients with a concurrent diagnosis of depression and spinal disorders seeking surgical intervention. Third, our necessary reliance on *ICD-9-CM* procedure and diagnosis codes has the inherent risk of reporting and coding bias. Fourth, the OSPHD data set does not capture the medical history of patients who received their previous care in another state. Finally, the incidences of depression in our CABG and hysterectomy cohorts were both lower than those described in previously published studies.[22–25] As an example, one study reported that 9% of CABG patients had new postoperative depression.[22] In our study, only 2.7% of the patients who underwent CABG were found to have a newly recorded diagnosis of depression on subsequent hospital

admission. In this context, a major assumption in our study is that hospital-recorded depression served as a proxy for the prevalence of outpatient postoperative depression. A comparison of inpatient and outpatient incidences of depression suggests that this assumption is not an unreasonable one.[26,27]

CONCLUSION

Our study findings suggest that a high proportion of patients who undergo spinal surgery experience new-onset depression in the postoperative period. Further studies to characterize the etiology of such depression should enable neurosurgeons to optimize the care of patients undergoing spinal surgery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations and Acronyms

CABG	coronary artery bypass grafting
CHF	congestive heart failure
COPD	chronic obstructive pulmonary disease
HR	hazard ratio
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
OSHPD	Office of Statewide Health Planning and Development

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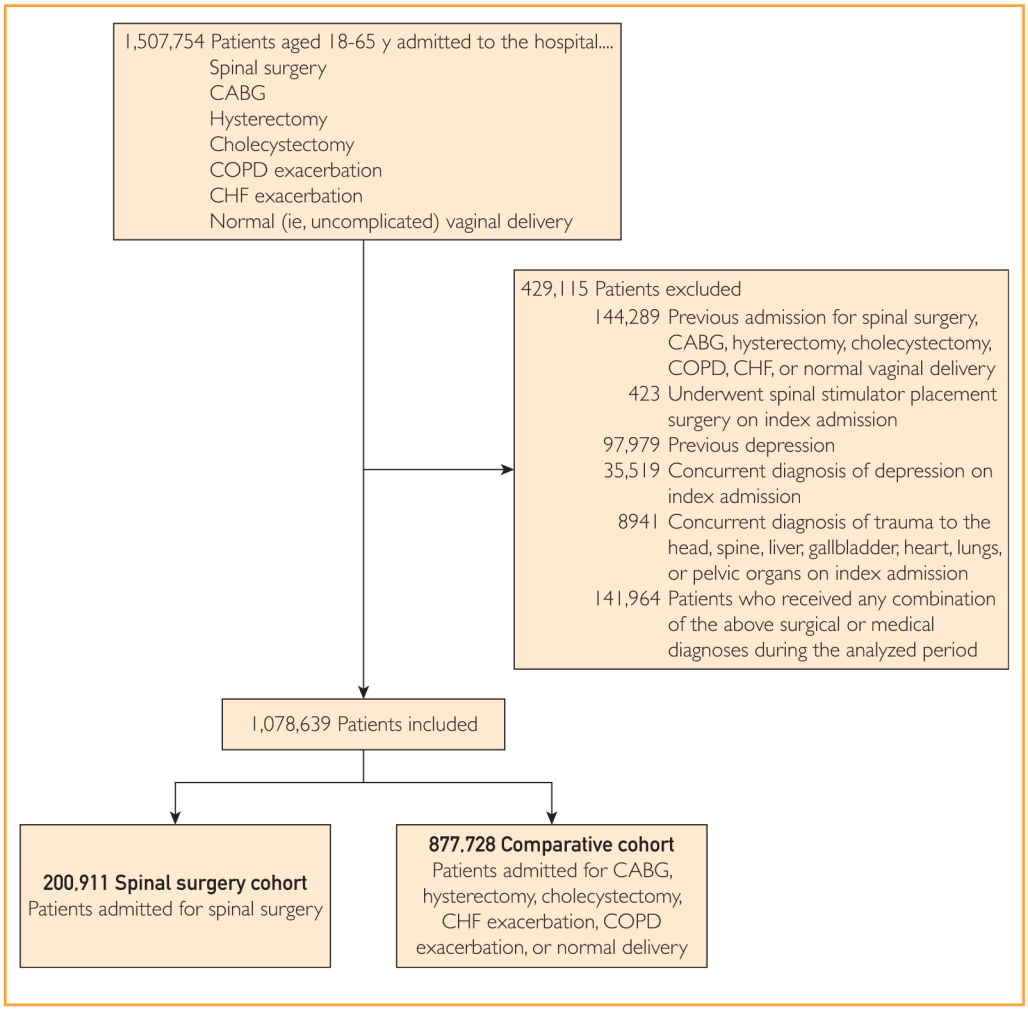

FIGURE.

Patient flowchart showing inclusion and exclusion criteria. Our spinal surgery cohort included patients hospitalized primarily for spinal surgery between 2000 and 2010 with no history (dating back to 1995) of spinal surgery or of admissions with comorbid depression. Our comparative cohort included patients hospitalized for 1 of 6 primary reasons (coronary artery bypass grafting [CABG], hysterectomy, cholecystectomy, chronic obstructive pulmonary disease [COPD], congestive heart failure [CHF], or normal vaginal delivery) between 2000 and 2010 with no prior admissions (dating back to 1995) for any of these reasons or prior admissions with comorbid depression. Patients were excluded from both cohorts if their index admission included a comorbid depression diagnosis or a diagnosis of trauma to the head, spine, liver, gallbladder, heart, lungs, or pelvic organs.

TABLE 1

Baseline Characteristics of the 1,078,639 Study Patients, Stratified by Cohort of Interest[a,b]

		Comparative cohort							
Variable	**Spinal surgery cohort (200,911 [18.6])**	**CABG (39,549 [3.7])**	**Hysterectomy (297,928 [27.6])**	**Cholecystectomy (212,010 [19.6])**	**CHF (53,718 [5.0])**	**COPD (25,618 [2.4])**	**Uncomplicated vaginal delivery (248,905 [23.1])**	**All comparative groups (877,728 [81.4])**	***P* value**
Age (y), mean (SD)	46.3 (10.5)	55.7 (6.5)	45.7 (7.5)	42.1 (12.6)	51.7 (9.5)	53.1 (9.2)	26.4 (4.9)	41.0 (12.8)	<.001
Male	118,596 (59.0)	33,595 (85.0)	0 (0)	61,442 (29.0)	34,699 (64.6)	13,311 (52.0)	0 (0)	143,047 (16.3)	<.001
Race/ethnicity									<.001
White	141,282 (70.3)	25,371 (64.2)	172,068 (57.8)	101,171 (47.8)	22,431 (41.8)	16,418 (64.1)	84,504 (34.0)	421,963 (48.1)	
Black	10,224 (5.1)	1323 (3.4)	25,458 (8.5)	11,012 (5.2)	10,931 (20.4)	3400 (13.3)	17,143 (6.9)	69,267 (7.9)	
Hispanic	17,036 (8.5)	2740 (6.9)	36,413 (12.2)	40,072 (18.9)	4531 (8.4)	1362 (5.3)	61,250 (24.6)	146,368 (16.7)	
Asian	8710 (4.3)	4314 (10.9)	24,809 (8.3)	13,733 (6.5)	4253 (7.9)	1137 (4.4)	27,202 (10.9)	75,448 (8.6)	
NA/other	23,659 (11.8)	5801 (14.7)	39,180 (13.2)	46,022 (21.7)	11,572 (21.5)	3301 (12.9)	58,806 (23.6)	164,682 (18.8)	
Length of hospital stay (index admission) (d), mean (median)	3.1 (2.0)	6.8 (6.0)	2.7 (3.0)	3.8 (3.0)	4.9 (3.0)	3.9 (3.0)	1.7 (2.0)	3.1 (2.0)	<.001
Insurance status									<.001
Private	118,184 (58.8)	27,445 (69.4)	223,427 (75.0)	126,463 (59.6)	20,842 (38.8)	9207 (35.9)	130,636 (52.5)	538,020 (61.3)	
MediCal	7561 (3.8)	2534 (6.4)	24,402 (8.2)	34,313 (16.2)	10,052 (18.7)	5578 (21.8)	87,414 (35.1)	164,293 (18.7)	
Medicare	7166 (3.6)	2388 (6.0)	4511 (1.5)	7119 (3.4)	6520 (12.1)	3761 (14.7)	300 (0.1)	24,599 (2.8)	
Self-pay	4511 (2.2)	1426 (3.6)	5635 (1.9)	15,284 (7.2)	8252 (15.4)	3068 (12.0)	7,777 (3.1)	41,442 (4.7)	
Other/missing	63,489 (31.6)	5756 (14.6)	39,953 (13.4)	28,831 (13.6)	8052 (15.0)	4004 (15.6)	22,778 (9.2)	109,374 (12.5)	
Index admission Charlson score									<.001
0	167,550 (83.4)	14,195 (35.9)	249,840 (83.9)	2036 (1.0)	23 (0.04)	12 (0.05)	248,756 (99.9)	514,862 (58.7)	
1–2	29,981 (14.9)	22,892 (57.9)	38,520 (12.9)	1180 (0.6)	37,559 (69.9)	23,211 (90.6)	147 (0.05)	123,509 (14.1)	
≥3	3380 (1.7)	2462 (6.2)	9568 (3.2)	208,794 (98.5)	16,136 (30.0)	2395 (9.4)	2 (0.0008)	239,357 (27.3)	
No. of episodes after index admission									<.001
≤1	163,858 (81.6)	31,112 (78.7)	269,412 (90.4)	176,928 (83.4)	24,293 (45.2)	13,862 (54.1)	208,028 (83.6)	723,635 (82.4)	
2–3	26,711 (13.3)	5935 (15.0)	20,560 (6.9)	23,263 (11.4)	12,172 (22.7)	5355 (20.9)	35,857 (14.4)	104,142 (11.9)	
4–11	9670 (4.8)	2379 (6.0)	7286 (2.4)	9588 (4.5)	13,550 (25.2)	5027 (19.6)	4896 (2.0)	42,726 (4.9)	
≥12	672 (0.3)	123 (0.3)	670 (0.2)	1231 (0.6)	3703 (6.9)	1374 (5.4)	124 (0.05)	7225 (0.8)	
Source of index admission									<.001

Variable	Spinal surgery cohort (200,911 [18.6])	Comparative cohort							*P* value
		CABG (39,549 [3.7])	Hysterectomy (297,928 [27.6])	Cholecystectomy (212,010 [19.6])	CHF (53,718 [5.0])	COPD (25,618 [2.4])	Uncomplicated vaginal delivery (248,905 [23.1])	All comparative groups (877,728 [81.4])	
Home	198,278 (98.7)	34,519 (87.3)	292,527 (98.2)	201,378 (95.0)	51,935 (96.7)	24,555 (95.8)	247,635 (99.5)	852,549 (97.1)	
Inpatient hospital care	2131 (1.1)	4907 (12.4)	4774 (1.6)	9311 (4.4)	1144 (2.1)	330 (1.3)	562 (0.2)	21,028 (2.4)	
Skilled nursing facility	54 (0.03)	8 (0.02)	47 (0.02)	155 (0.1)	196 (0.4)	183 (0.7)	32 (0.01)	621 (0.1)	
Residential care facility	41 (0.02)	9 (0.02)	62 (0.02)	165 (0.1)	112 (0.2)	341 (1.3)	73 (0.03)	762 (0.1)	
Prison/jail/invalid	407 (0.2)	106 (0.3)	518 (0.2)	1001 (0.5)	331 (0.6)	209 (0.8)	603 (0.2)	2768 (0.3)	
Transferred on index admission	10,188 (5.1)	2114 (5.4)	3522 (1.2)	4930 (2.3)	9332 (17.4)	2747 (10.7)	782 (0.3)	23,427 (2.7)	<.001

[a]CABG = coronary artery bypass grafting; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; NA = not available.

[b]Data are presented as No. (percentage) of patients unless indicated otherwise. Percentages may not total 100 because of rounding.

TABLE 2

Baseline Characteristics of the Spinal Surgery Cohort With and Without Newly Recorded Depression on Hospital Readmission (Unadjusted)[a]

Variable	Spinal surgery cohort (N=200,911)		*P* value
	No depression within 5 y (n=190,654 [94.9])	Depression within 5 y (n=10,257 [5.1])	
Age (y), mean (SD)	46.2 (10.5)	47.5 (10.0)	<.001
Male	114,042 (59.8)	4554 (44.4)	<.001
Race/ethnicity			<.001
White	133,895 (70.2)	7387 (72.0)	
Black	9676 (5.1)	548 (5.3)	
Hispanic	16,693 (8.8)	343 (3.3)	
Asian	8453 (4.4)	257 (2.5)	
Other	21,937 (11.5)	1722 (16.8)	
Length of hospital stay (index admission) (d), mean (median)	3.0 (2.0)	4.2 (3.0)	<.001
Insurance status			<.001
Private	113,020 (59.3)	5164 (50.4)	
MediCal	6926 (3.6)	635 (6.2)	
Medicare	6424 (3.4)	742 (7.2)	
Self-pay	3830 (2.0)	681 (6.6)	
Other/missing	60,454 (31.7)	3035 (29.6)	
Index admission Charlson score			<.001
0	159,830 (83.8)	7720 (75.3)	
1–2	27,847 (14.6)	2134 (20.8)	
≥3	2977 (1.6)	403 (3.9)	
No. of episodes after index admission			<.001
≤1	160,682 (84.3)	3176 (31.0)	
2–3	22,768 (11.9)	3934 (38.4)	
4–11	6886 (3.6)	2784 (27.1)	
≥12	318 (0.2)	363 (3.5)	
Source of admission			<.001
Home	188,188 (98.7)	10,090 (98.4)	
Inpatient hospital care	1998 (1.1)	133 (1.3)	
Skilled nursing facility	50 (0.03)	4 (0.04)	
Residential care facility	35 (0.02)	6 (0.1)	
Prison/jail/invalid	383 (0.2)	24 (0.2)	
Transferred on index admission	7843 (4.1)	2345 (22.9)	<.001

Variable	Spinal surgery cohort (N=200,911)		*P* value
	No depression within 5 y (n=190,654 [94.9])	Depression within 5 y (n=10,257 [5.1])	
Time to depression (mo), mean (median)	Not applicable	24.0 (21.9)	<.001
Surgical subtype			<.001
Spinal fusion	79,946 (41.9)	2397 (23.4)	
Multiple spinal operations	79,623 (41.8)	3528 (34.4)	
All other spinal operations (nonfusion, one-time operations)	31,085 (16.3)	4332 (42.2)	
Primary diagnosis on index admission			<.001
Spondylosis	19,647 (10.3)	1217 (11.9)	
Spinal stenosis	16,238 (8.5)	989 (9.6)	
Radiculopathy	92,767 (48.7)	3859 (37.6)	
Degenerative disk disease	34,774 (18.2)	2145 (20.9)	
Spondylolisthesis	9259 (4.9)	574 (5.6)	
Metastatic disease	975 (0.5)	127 (1.2)	
Kyphosis/scoliosis	1237 (0.6)	106 (1.0)	
Other[b]	15,757 (8.3)	1240 (12.1)	

[a] Data are presented as No. (percentage) of patients unless indicated otherwise. Percentages may not total 100 because of rounding.

[b] Consists of diagnosis groupings that comprised less than 0.5% of all spinal surgery diagnoses, many of which included terms such as “other” or “unspecified.”

TABLE 3

Proportional Hazard Ratios for a New Diagnosis of Depression at Hospital Readmission, Stratified by Cohort of Interest

	Unadjusted HR (95% CI)	Adjusted HR (95% CI)				
Reason for index admission	**Overall (5 y)**	**Overall (5 y)**	**1 Year**	**2 Years**	**3 Years**	**4 Years**
Vaginal delivery	Reference	Reference	Reference	Reference	Reference	Reference
Spinal surgery	6.29 (6.01–6.59)	5.05 (4.79–5.33)	8.92 (7.89–10.08)	6.75 (6.22–7.34)	5.91 (5.53–6.33)	5.33 (5.02–5.65)
CABG	3.17 (2.95–3.41)	2.33 (2.15–2.54)	4.60 (3.91–5.42)	3.31 (2.94–3.73)	2.75 (2.48–3.05)	2.43 (2.22–2.67)
Hysterectomy	2.91 (2.77–3.05)	3.04 (2.88–3.21)	4.21 (3.73–4.76)	3.50 (3.22–3.80)	3.25 (3.04–3.48)	3.08 (2.90–3.26)
Cholecystectomy	4.08 (2.88–4.28)	2.51 (2.35–2.69)	3.37 (2.94–3.86)	2.91 (2.65–3.21)	2.70 (2.49–2.92)	2.54 (2.37–2.73)
CHF	15.18 (14.45–15.95)	2.44 (2.28–2.61)	4.59 (3.99–5.27)	3.44 (3.12–3.79)	2.92 (2.69–3.17)	2.59 (2.42–2.79)
COPD	16.98 (16.07–17.94)	3.04 (2.83–3.26)	5.89 (5.10–6.80)	4.34 (3.92–4.81)	3.65 (3.35–3.98)	3.21 (2.97–3.47)

CABG = coronary artery bypass grafting; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; HR = hazard ratio.

TABLE 4

Adjusted Proportional Hazard Ratios for a New Diagnosis of Depression at Hospital Readmission, Stratified by Spinal Surgery Subgroup

Variable	Adjusted hazard ratio (95% CI) (overall [5 y])
Spinal surgery subtype	
Fusion (n=83,151)	1.28 (1.22–1.36)
Multiple spinal operations (n=35,417)	1.22 (1.16–1.29)
All other spinal operations (ie, one-time, nonfusion spinal surgery) (n=82,343)	Reference
Primary diagnosis on index admission	
Spondylosis	Reference
Spinal stenosis	0.95 (0.87–1.04)
Radiculopathy	0.87 (0.81–0.93)
Degenerative disk disease	1.06 (0.99–1.13)
Spondylolisthesis	0.94 (0.85–1.04)
Metastatic disease	1.34 (1.07–1.66)
Kyphosis/scoliosis	0.99 (0.81–1.21)
Other[a]	1.00 (0.92–1.09)

[a]Consists of diagnosis groupings that comprised less than 0.5% of all spinal surgery diagnoses, many of which included terms such as “other” or “unspecified.”